

ERA OF THE OLD RED SANDSTONE—
FISHES ABUNDANT.

WE advance to a new chapter in this marvellous history—the era of the *Old Red Sandstone System*. This term has been recently applied to a series of strata, of enormous thickness in the whole mass, largely developed in Herefordshire, Shropshire, Worcestershire, and South Wales; also in the counties of Fife, Forfar, Moray, Cromarty, and Caithness; and in Russia and North America, if not in many other parts of the world. The particular strata forming the system are somewhat different in different countries; but there is a general character to the extent of these being a mixture of flagstones, marly rocks, and sandstones, usually of a laminous structure, with conglomerates. There is also a schist shewing the presence of bitumen; a remarkable

new ingredient, since it is a vegetable production. In the conglomerates, of great extent and thickness, which form, in at least one district, the basis or leading feature of the system, inclosing water-worn fragments of quartz and other rocks, we have evidence of the seas of that period having been subjected to a violent and long-continued agitation, probably from volcanic causes. The upper members of the series bear the appearance of having been deposited in comparatively tranquil seas. The English specimens of this system shew a remarkable freedom from those disturbances which result in the interjection of trap; and they are thus defective in mineral ores. In some parts of England the old red sandstone system has been stated as 10,000 feet in thickness.

In this era, the forms of life which existed in the Silurian are continued: we have the same orders of marine creatures, zoophyta, polypiaria, conchifera, crustacea; but to these are added numerous fishes, some of which are of most extraordinary and surprising forms. Several of the strata are crowded with remains of fish, shewing that the seas in which those beds were deposited had swarmed with that class of inhabitants. The in-

vestigation of this system is recent ; but already* M. Agassiz has ascertained about twenty genera, and thrice the number of species. And it is remarkable that the Silurian fishes are here only represented in genera ; the whole of the *species* of that era had already passed away. Even throughout the sub-groups of the system itself, the species are changed ; and these are phenomena observed throughout all the subsequent systems or geological eras ; apparently arguing that, during the deposition of all the rocks, a gradual change of physical conditions was constantly going on. A varying temperature, or even a varying depth of sea, would at present be attended with similar changes in marine life ; and by analogy we are entitled to assume that such variations in the ancient seas might be amongst the causes of that constant change of genera and species in the inhabitants of those seas to which the organic contents of the rocks bear witness.

Some of the fossils of this system,—the cephalaspis, coccosteus, pterichthys, holoptychius—are, in form and structure, entirely different from any fishes now existing, only the sturgeon family having any trace of affinity to them in any respect.

* June, 1842.

They seem to form a sort of connecting link between the crustacea and true fishes.

The *cephalaspis* may be considered as making the smallest advance from the crustacean character ; it very much resembles in form the asaphus of lower formations, having a longish tail-like body inserted within the cusp of a large crescent-shaped head, somewhat like a saddler's cutting-knife. The body is covered with strong plates of bone, enamelled, and the head was protected on the upper side with one large plate, as with a buckler—hence the name, implying *buckler-head*. A range of small fins conveys the idea of its having been as weak in motion as it is strong in structure. The *coccosteus* may be said to mark the next advance to fish creation. The outline of its body is of the form of a short thick coffin, rounded, covered with strong bony plates, and terminating in a long tail, which seems to have been the sole organ of motion. It is very remarkable, that, while the tail establishes this creature among the vertebrata and the fishes, its mouth has been opened vertically, like those of the crustaceans, but which is contrary to the mode of vertebrata generally. This seems a pretty strong mark of the link character of the *coccosteus* between these two great departments of the animal

kingdom. The *pterichthys* has also strong bony plates over its body, arranged much like those of a tortoise, and has a long tail; but its most remarkable feature, and that which has suggested its name, is a pair of long and narrow wing-like appendages attached to the shoulders, which the creature is supposed to have erected for its defence when attacked by an enemy.

The *holoptychius* is of a flat oval form, furnished with fins, and ending in a long tail; the whole body covered with strong plates which overlap each other, and the head forming only a slight rounded projection from the general figure. The specimens in the lower beds are not above the size of a flounder; but in the higher strata, to judge by the size of the scales or plates which have been found, the creature attained a comparatively monstrous size.

The other fishes of the system,—the *osteolepis*, *glyptolepis*, *dipterus*, &c., are, in general outline, much like fishes still existing, but their organization has, nevertheless, some striking peculiarities. They have been entirely covered with bony scales or plates, enamelled externally; their spines are tipped with bone, and, as one striking and unvarying feature, the tail is only finned on the lower

side. The internal skeleton, of which no traces have been preserved, is presumed to have been cartilaginous. They therefore unite the character of cartilaginous fishes with a character peculiar to themselves, and in which we see pretty clear vestiges of the pre-existent crustaceous form.

With regard to the link character of these animals, some curious facts are mentioned. It appears that in the imperfect condition of the vertebral column, and the inferior situation of the mouth in the pterichthys, coccosteus, &c., there is an analogy to the form of the dorsal cord and position of the mouth in the embryo of perfect fishes. The one-sided form of the tail in the osteolepis &c. finds a similar analogy in the form of the tail in the embryo of the salmon. It is not premature to remark how broadly these facts seem to hint at a parity of law affecting the progress of general creation, and the progress of an individual foetus of one of the more perfect animals.

It is equally ascertained of the types of being prevalent in the old red, as of those of the preceding system, that they are uniform in the corresponding strata of distant parts of the earth; for instance, Russia and North America.

In the old red sandstone, the marine plants, of

which faint traces are observable in the Silurians, continue to appear. It would seem as if less change took place in the vegetation than in the animals of those early seas; and for this, as Mr. Miller has remarked, it is easy to imagine reasons. For example, an infusion of lime into the sea would destroy animal life, but be favourable to vegetation.

As yet there were no land animals or plants, and for this the presumable reason is, that no dry land as yet existed. We are not left to make this inference solely from the absence of land animals and plants; in the arrangement of the primary (stratified) rocks, we have further evidence of it. That these rocks were formed in a generally horizontal position, we are as well assured as that they were formed at the bottom of seas. But they are always found greatly inclined in position, tilted up against the slopes of the granitic masses which are beneath them in geological order, though often shooting up to a higher point in the atmosphere. No doubt can be entertained that these granitic masses, forming our principal mountain ranges, have been protruded from below, or, at least, thrust much further up, *since* the deposition of the primary rocks. The protrusion was what

tilted up the primary rocks; and the inference is, of course, unavoidable, that these mountains have risen chiefly, at least, since the primary rocks were laid down. It is remarkable that, while the primary rocks thus incline towards granitic nuclei or axes, the strata higher in the series rest against these again, generally at a less inclination, or none at all, shewing that these strata were laid down after the swelling mountain eminences had, by their protrusion, tilted up the primary strata. And thus it may be said an era of local upthrowing of the primitive and (perhaps) central matter of our planet, is established as happening about the close of the primary strata, and beginning of the next ensuing system. It may be called the *Era of the Oldest Mountains*, or, more boldly, of the formation of the detached portions of dry land over the hitherto watery surface of the globe—an important part of the designs of Providence, for which the time was now apparently come. It may be remarked, that volcanic disturbances and protrusions of trap took place throughout the whole period of the deposition of the primary rocks; but they were upon a comparatively limited scale, and probably all took place under water. It was only now that the central granitic masses of the great

mountain ranges were thrown up, carrying up with them broken edges of the primary strata; a process which seems to have had this difference from the other, that it was the effect of a more tremendous force exerted at a lower depth in the earth, and generally acting in lines pervading a considerable portion of the earth's surface. We shall by-and-by see that the protrusion of some of the mountain ranges was not completed, or did not stop, at that period. There is no part of geological science more clear than that which refers to the ages of mountains. It is as certain that the Grampian mountains of Scotland are older than the Alps and Apennines, as it is that civilization had visited Italy, and had enabled her to subdue the world, while Scotland was the residence of "roving barbarians." The Pyrenees, Carpathians, and other ranges of continental Europe, are all younger than the Grampians, or even the insignificant Mendip Hills of southern England. Stratification tells this tale as plainly as Livy tells the history of the Roman republic. It tells us—to use the words of Professor Philips—that at the time when the Grampians sent streams and detritus to straits where now the valleys of the Forth and Clyde meet, the greater part of Europe was a wide ocean.

The last three systems—called, in England, the Cumbrian, Silurian, and Devonian, and collectively the palæozoic rocks, from their containing the remains of the earliest inhabitants of the globe—are of vast thickness; in England, not much less than 30,000 feet, or nearly six miles. In other parts of the world, as we have seen, the earliest of these systems alone is of much greater depth—arguing an enormous profundity in the ocean in which they were formed.